CLAIMS

What is claimed is:

1. A control system that limits the wattage provided by a heat-producing element to a value less than that produced at full line voltage, the system comprising:

at least one heat-producing means;

a power control means operatively associated with said at least one heat-producing means; and

a power limiting function that limits the wattage provided by said at least one heat-producing means to a value less than that produced at a full line voltage through the use of a scaling function.

2. The control system according to Claim 1 wherein said power limiting function and said scaling function resides in a module attached to said at least one heat-producing means or operatively placed between said power control means and said at least one heat-producing means.

3. The control system according to Claim 1 wherein said power limiting function and said scaling function resides in a

module operatively placed between a power source and said power control means.

4. The control system according to Claim 1 wherein said power limiting function and said scaling function resides in said power control means operatively placed between a power source and said at least one heat-producing means.

5. The control system according to Claim 1 wherein said power limiting function and said scaling function resides in a module operatively placed between the output of any control device and the control input to said power control means which controls said at least one heat-producing means.

6. The control system according to Claim 1 wherein said power control means is phase angle fired and includes circuit provision to enhance the accuracy of phase angle power control at low conduction angles, by allowing one or more "off" cycles to occur between phase-angle-fired "on" cycles, thereby allowing an increase in the conduction angle of said phase-angle-fired "on" cycles.

7. The control system according to Claim 1 further comprising a temperature controller, said temperature controller including:

a temperature sensing function such that a process temperature operatively associated with said at least one heat-producing means may be determined;

a temperature comparison function for comparing a temperature associated with said at least one heat-producing means with a set point temperature and determining the required output; and

an output function that provides, directly or through the use of an ancillary power control means, a method to vary the power supplied to the heat-producing means.

8. A variable wattage control system for providing varying wattage levels for a power-receiving device, the system comprising:

at least one power-receiving device operatively associated with a temperature sensing means;

the temperature sensing means communicating with a temperature controller for comparing a sensed temperature with a predetermined set point;

a power controller operatively associated with said temperature controller for providing energization of said at

least one power-receiving device at a selected maximum wattage level;

the temperature controller being operative such that, if said sensed temperature, when compared to the set point, indicates that the system requires heat, the temperature controller directs the power controller to energize said at least one power-receiving device, which is limited to a specific maximum wattage level;

a micro-controller which determines a power output scaling factor based on the percentage of a full line voltage being applied to said at least one power-receiving device and then scales said power output scaling factor accordingly;

said power output scaling factor determining the maximum percentage power to be applied to said at least one power-receiving device; and

such that a said at least one power-receiving device may be driven at different power levels for various applications.

9. The variable wattage control system according to claim 8 wherein the power controller controls power to said at least one power-receiving device by conduction angle control, and includes circuitry to increase conduction angles at low power output levels.

10. The variable wattage control system according to claim 8, wherein said temperature controller operates such that temperature readings are communicated to said temperature controller by said sensing means, and when said temperature readings are so communicated, said temperature controller then provides a re-scaled output to said power controller which limits and re-scales the amount of voltage applied to said at least one power-receiving device, whereby said power controller permits multiple wattage values to be obtained from a single resistance value of said at least one power-receiving device.

11. The variable wattage control system according to claim 10 wherein said scaling allows said at least one power-receiving device having a single wattage rating to be used as a power-receiving device having multiple wattage applications.

12. The variable wattage control system according to claim 11 further being capable of powering any type of possible said at least one power-receiving device within a range of possible power ratings, and by change of said scaling factor, such that system operation is matched to the maximum desired power level of said at least one heat producing means.

13. The variable wattage control system according to claim 12 wherein said temperature controller provides a linear output range for selecting an operating power level of said at least one power-receiving device for operation thereof at a sensed temperature at said preselected set point regardless of whether the system has a maximum power level greater than that of said of at least one power-receiving device, and wherein an upper limit of said linear output range will correspond to the maximum desired power level of said at least one power-receiving device.

14. The variable wattage control system according to claim 12 wherein said linear output range is an industry standard.

15. The variable wattage control system according to claim 12 wherein said linear output range is a 4-20 mA output range.

16. The variable wattage control system according to claim 10 wherein:

said micro-controller is operative to determine a power output scaling factor according to a scaling function, based on the percentage of a full line voltage being applied to said at least one power-receiving device by first calculating available power at a full line voltage using the following equation:

$$P_{line} = \frac{(V_{line})^2}{R_{heater}}$$

and is further operative then to scale the power output to be applied to said at least one power-receiving device by calculating said power output scaling factor, K_{out}, using the following equation:

$$K_{out} = \frac{P_{desired}}{P_{line}}$$

said temperature sensing means being operative such that it communicates then said sensed temperature reading to the micro-controller; and

said micro-controller being further operative such that it compares said sensed temperature to the predetermined set point, and determines a required percentage power output level, P_{out}, and then calculates a scaled percentage power output, $P_{out\ scaled}$, using the following equation:

$$P_{out\ scaled} = P_{out} * K_{out}$$

said micro-controller being still further operative to instruct said temperature controller to communicate a signal to

said power controller establishing the desired power output to said at least one power-receiving device;

whereby said power controller provides a power output to said at least one power-receiving device which is properly scaled.

17. The variable wattage control system according to claim 16 wherein said micro-controller is operative as set forth in response to a software program of the system.

18. The variable wattage control system according to claim 17 wherein the micro-controller is operated by a software subsystem having said software to permit manual user input of various parameters into the variable wattage control system in order to determine said scaling function.

19. The variable wattage control system according to claim 8 wherein said scaling function is optionally manually preset or is preset prior to shipment to the end user or is electronically communicated to the system or is determined automatically by the system in response to a user input.

20. A variable wattage control system comprising:

a heat-producing means which is electrically powered;

a power control means which is linked to either a DC or AC power source for supplying power to said heat-producing means;

a sensing means operatively associated with said heat producing means for taking temperature readings associated with said heat-producing means and communicating these readings to a temperature controller; and

said power control means operating such that, when said temperature readings are communicated to said temperature controller by the sensing means, said temperature controller provides a re-scaled output to said power control means which limits and re-scales the output power applied to said heat-producing means by using a scaling factor in accordance with ratings specification of said heat-producing means.

21. The variable wattage control system according to claim 20 wherein said scaling factor is manually user preset or is preset prior to shipment to the end user or is electronically communicated to the system or is determined automatically by the system in response to a user input.

22. The variable wattage control system according to claim 20 further comprising a control provision permitting a user of the system to preselect values of line voltage, resistance and a desired maximum power of said heat producing means, such that the

system calculates a desired scaling factor, the factor being applied by a software subsystem to re-scale the power out by control of voltage to said heat producing means from said power control means.

23. The variable wattage control system according to claim 22 wherein control provision is constituted by said software subsystem that permits the user to manually enter line voltage, electrical resistance of the heat-producing means and desired maximum power of the heat-producing means in order to calculate a desired scaling factor appropriate to said heating-producing means.

24. The variable wattage control system according to claim 20 wherein a software subsystem is either part of said temperature controller, or part of said power control means, or is a separate arrangement operatively associated between said power control means and said heating-producing means or between said temperature controller and said power control means.

25. The variable wattage control system according to claim 20 wherein said power control means controls power level supplied to said heating-producing means by semiconductor power control or mechanical power switching means.

26. The variable wattage control system according to claim 25 wherein said power control means controls power level supplied to said heat-producing means by phase angle control, burst firing, pulse mode, or pulse width modulation.

27. The variable wattage control system according to claim 25 wherein said power control means controls power level supplied to said heat-producing means by phase angle control, and includes circuit provision to enhance the accuracy of phase angle power control at low conduction angles, by allowing "off" cycles to occur between phase-angle-fired "on" cycles, thereby allowing an increase in the conduction angle of said phase-angle-fired "on" cycles.

28. A variable wattage control system for providing varying wattage levels for a power-receiving device, the system comprising:

at least one power-receiving device operatively associated with a sensing means for sensing an operating parameter of said power-receiving device;

said sensing means communicating with a sensor-responsive controller for comparing said sensed operating parameter with a predetermined set point;

a power control means of said sensor-responsive controller, for providing energization of said power-receiving device at a selected wattage level;

the sensor-responsive controller being operative such that, if said sensed operating parameter, when compared to the said predetermined set point, indicates the need for more power from said power-receiving device, said sensor-responsive controller directing said power control means to energize said power-controlled device, which is limited to a specific maximum wattage level;

a micro-controller which determines a power output scaling factor based on the percentage of a full line voltage being applied to said power-receiving device and then scales said power output accordingly; and

said power output scaling factor determining the maximum percentage power to be applied to said power-receiving device;

such that said power-receiving device may be driven at different power levels for various applications with a power rating specification as great or less than the power rating specification of the system.

29. A method of variable wattage control comprising the steps of:

a) providing an electrically powered heat-producing means, a power control means linked to a power source for supplying power to heat-producing means, a sensing means operatively associated with said heat-producing means for sensing temperature associated with the heat-producing means and communicating signals corresponding to the sensed temperature to a temperature controller for controlling the power control means to apply power to the heat-producing means according to the sensed temperature;

b) determining a scaling factor output for applying power applied to the heat-producing means by the power control means in accordance with ratings specification of said heat-producing means;

c) communicating the sensed temperature to the temperature controller;

d) causing the temperature controller to have a re-scaled output to the power control means which limits and re-scales output power from the power control means; and

e) applying power from the power control means to the heat-producing means at a power level determined by the temperature controller to maintain said temperature relative to a temperature set point;

whereby the power level supplied to the heat-producing means is scaled according to said scaling factor.

30. The method according to claim 29, further characterized by determining the scaling factor in accordance with line voltage, heater element resistance and desired maximum power which can be delivered to the heat-producing means.

31. The method according to claim 29, further characterized by:

f) employing a software subsystem that permits a user of the system to enter line voltage, heater element resistance and desired maximum power to the heat-producing means; and

g) calculating by said software subsystem a desired scaling factor.

32. The method according to claim 29 wherein said scaling factor is manually preset by the user or is preset prior to shipment to the end user or is electronically communicated to the system or is determined automatically by the system in response to a user input.

33. A method of variable wattage heater control comprising the steps of:

a) providing an electrically powered heater, a power control means linked to power source for supplying power to the

heater, a sensing means operatively associated with the heater for sensing temperature associated with the heater and communicating signals corresponding to the sensed temperature to a temperature controller for controlling the power control means to apply power to the heater according to the sensed temperature,

b) employing a micro-controller to determine a power output scaling factor according to a scaling function, based on the percentage of a full line voltage being applied to the heater, by first calculating available power at full line voltage using the following equation:

$$P_{line} = \frac{(V_{line})^2}{R_{heater}}$$

c) then scaling the power output applied to the heater by calculating said power output scaling factor, K_{out}, using the following equation:

$$K_{out} = \frac{P_{desired}}{P_{line}}$$

d. operating the temperature sensing means such that it communicates the sensed temperature reading to the micro-controller;

e. operating the micro-controller such that it compares the sensed temperature to a predetermined temperature set point and determines a required percentage power output level, P_{out}, and then calculates a scaled percentage power output, $P_{out\ scaled}$, using the following equation:

$$P_{out\ scaled} = P_{out} * K_{out}$$

and

f) operating the micro-controller such that said micro-controller instructs the temperature controller to communicate a signal to the power control means and establishing the desired power output to the heater element;

whereby the power control means provides a power output to the heater which is properly scaled for the heater.

34. A method of using a variable wattage control system for providing varying wattage levels for a heating element, where the heating element may be required to be driven at power levels less than the power level capability of system comprising the steps of:

a) using a temperature sensing means for measurements of a temperature associated with the heating element during operation thereof;

b) providing the temperature measurements to a temperature controller for comparing the temperature measurements with a predetermined set point;

c) using a power control means of the temperature controller, for providing energization of the heating element at a selected wattage level;

the temperature controller operating such that, if the sensed temperature, when compared to the predetermined set point, indicates the system requires more heat, the temperature controller directs said power control means to energize the heating element, which is limited to a specific maximum wattage level; and

d) using a micro-controller to determine a power output scaling factor based on the percentage of a full line voltage being applied to the heating element; and

e) scaling the power output accordingly; and

f) causing the power output scaling factor to determine the maximum percentage power to be applied to the heating element;

such that the heating element is not driven at a power level greater than its power level rating.

35. The method according to claim 34 wherein, said step d) further comprises providing to the micro-controller

the line voltage of a power source for the power control means, electrical resistance of the heating element and desired maximum power of the heating element.